

# The role of postoperative antibiotics in facial fractures: Comparing the efficacy of a 1-day versus a prolonged regimen

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<b>BACKGROUND:</b>	The goal of this study was to evaluate the influence of the duration of postoperative antibiotics (1 day vs. $\geq 5$ days) on wound infections following surgical treatment of facial fractures.
<b>METHODS:</b>	Three hundred thirty-nine patient case histories with a total of 498 fractures were reviewed retrospectively with regard to infections occurring within a 6-month period following surgical management. Patients were divided into two groups based on the duration of postoperative antibiotics administered. Group A consisted of 125 patients who had 1 day of postoperative antibiotics, whereas Group B consisted of 214 patients who had five or more days of postoperative antibiotics. Statistical analysis was conducted to assess for possible differences in the rate of postoperative infections.
<b>RESULTS:</b>	Five patients in Group A (4%) and seven patients in Group B (3.27%) developed infections within the follow-up period. Of these 12 patients, seven had sustained multiple facial bone fractures. Eleven infections occurred in patients with mandibular fractures and one in a midfacial fracture. Statistical analysis using Fisher's exact test showed no significant difference ( $p = 0.77$ ) in the incidence of infection between Groups A and B.
<b>CONCLUSION:</b>	In this retrospective study, the use of prolonged postoperative antibiotics in uncomplicated mandibular and midfacial fractures had no significant benefit in reducing the incidence of infections. ( <i>J Trauma Acute Care Surg.</i> 2014;76: 720–724. Copyright © 2014 by Lippincott Williams & Wilkins)
<b>LEVEL OF EVIDENCE:</b>	Therapeutic study, level IV.
<b>KEY WORDS:</b>	Postoperative antibiotics; facial fractures; antimicrobial prophylaxis; trauma.

In maxillofacial trauma, fractures often communicate with the skin surface, oral cavities, or sinus cavities, which are contaminated with endogenous flora. Even in closed fractures, surgical treatment often entails an approach through a contaminated field. Procedures to surgically reduce and fix these fractures are hence classified as “clean-contaminated” operations, with a reported incidence of postoperative infection between 10% and 15% without the use of prophylactic antibiotics.<sup>1–3</sup>

The proper use of antibiotics in surgical interventions for facial fractures can have a significant effect on reducing postoperative infections, as demonstrated by authors such as Chole and Yee.<sup>4</sup> However, the use of prophylactic antibiotics might have adverse effects and contribute to the development of resistant strains of bacteria, in addition to the risk of potentially serious adverse reactions in certain individuals. In the literature, the antibiotic duration varies from a single dose<sup>5,6</sup> up to 7 or even 10 days postoperatively.<sup>7–10</sup> The lack of a consensus in the literature as to the most efficacious postoperative antibiotic regimen after facial fractures led us to conduct a retrospective study in an attempt to answer this question.

In this study, we reviewed the infection rates of our patients treated before and after April 2011. In April 2011, following a series of randomized, double-blind, placebo-controlled studies on the effect of different postoperative antibiotic durations on infection conducted in our clinic,<sup>11,12</sup> the standard postoperative antibiotic regimen for facial fractures in patients with no elevated risk of infection was shortened from at least 120 hours to 24 hours. This gave us a unique opportunity to compare the incidence of infections between a 1-day versus a prolonged ( $\geq 5$  days) postoperative prophylactic antibiotic regimen after surgical intervention in facial fractures.

## PATIENTS AND METHODS

### Patients

During a period of 3 years from April 2009 to April 2012, 583 patients with maxillofacial or mandibular fractures were surgically treated at the University Hospital of Bern, Switzerland, by surgeons of the Department of Cranio-Maxillofacial Surgery. At admission, details of each patient such as age, sex, mechanism of injury, and duration from trauma to admission were routinely recorded. Preoperative radiographic examination was performed either with panoramic tomography or computed tomography scans, depending on the fracture location and surgical requirements. The fracture sites and presence of any other associated injuries were noted preoperatively.

These case records were reviewed, and patients were excluded when any of the following criteria were present: (i) need for intensive care; (ii) acute bacterial infection, gunshot wounds, or pathologic fracture (as a result of cysts, metastases,

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etc.); (iii) fracture of the skull base with rhinoliquorrhoea or intracranial emphysema; (iv) history of malignancy or radiation to the head and neck; (v) compromised host defense (immunosuppression, malabsorption, maldigestion, cachexia, bisphosphonate use, agranulocytosis, or reduced body weight [ $<40$  kg or body mass index  $<17$ ]); (vi) severe renal insufficiency (stage  $\geq 4$  according to the Kidney Disease Outcomes Quality Initiative);<sup>13</sup> (vii) patients with follow-up of less than 6 months; or (viii) patients included in other concurrent studies.

## Antimicrobial Prophylaxis

All patients were started on intravenous antibiotics on admission. One of two possible antibiotics was administered.

1. Amoxicillin/clavulanic acid 1.2 g intravenously every 8 hours from admission until 24 hours postoperatively.
2. If the patient was allergic to penicillin, clindamycin 600 mg intravenously every 8 hours from admission until 24 hours postoperatively was administered instead.

Patients treated from April 2011 to April 2012 (1 year) whose condition did not require prolonged antibiotic therapy received no further postoperative antibiotics, just the three doses of intravenous antibiotics within the first 24 hours postoperatively (Group A).

Patients treated in the period from April 2009 to March 2011 (2 years) received postoperatively antibiotics for 5 days or more (Group B). Hence, patients who were on intravenous amoxicillin/clavulanic acid then received 1,000 mg orally three times a day, while patients who were on intravenous clindamycin received 300 mg orally three times a day, both for an additional 4 days or more.

## Surgical Technique

All operations were performed under general anesthesia by a team consisting of a senior surgeon, a junior surgeon, and a staff member. The surgical site was thoroughly prepared with a 10% povidone-iodine solution (Betadine, Mundipharma Medical Company, Basel, Switzerland) or an iodine-free 0.1% octenidine dihydrochloride (potentiated with addition of 2% phenoxylethanol) wound disinfection solution (Octenisept, Schuülke & Mayr, Norderstedt, Germany) if iodine allergy was reported. Intraoral disinfection was performed with a 0.1% chlorhexidine gluconate antiseptic solution (Chlorhexamed 0.1%, GlaxoSmithKline, Brentford, United Kingdom). Surgical approach to the fracture sites was dependent on the location and type of fracture and could involve intraoral, extraoral, transconjunctival, or a combination of these approaches.

Fracture sites included mandibular fractures, fractures of the zygomatic complex, Le Fort I or II type fractures, and orbital floor fractures. Most fractures were reduced and fixed with titanium miniplates and screws (Medartis, Basel, Switzerland; or Synthes, Oberdorf, Switzerland; or Stryker, Solothurn, Switzerland). Where necessary, orbital floor fractures were reconstructed with an Ethisorb patch (Ethicon Inc., NJ), Polymax resorbable plate (Synthes, Oberdorf, Switzerland), or titanium mesh plate (Medartis or Synthes). The mucosal incisions were closed using Vicryl or Vicryl-Rapide (Ethicon Inc.), and skin closure was performed using Prolene sutures (Ethicon Inc.).

## Postoperative Management

Patients were followed up regularly for 6 months after surgery as per department protocol. All wounds and fracture sites were inspected at each review appointment to identify any surgical site infections according to the criteria established by the Centers for Disease Control and Prevention.<sup>14</sup>

Criteria for infection included purulent discharge (with or without microbiologic confirmation), spontaneous wound dehiscence, abscess formation, or deliberate opening of the wound by a surgeon in the presence of signs and symptoms of infection such as localized pain, tenderness, or fever ( $>38^{\circ}\text{C}$ ).

## Infection Treatment

In cases of postoperative wound dehiscence or superficial purulent infection, patients were treated with local measures including drainage and daily wound irrigation with povidone-iodine (Betadine). In cases of deeper infection, the department protocol included the immediate use of a broad-spectrum antibiotic with subsequent modification if needed, depending on the results of culture and sensitivity tests.

## Statistical Analysis

Based on the prevalence of infection after surgical treatment of facial fractures in previous studies, we estimated that a sample size of 110 in each group would be needed for a power of 80% and Type I error level of 5% (one-tailed) (Power and Precision 3.2, Biostat Inc., NJ). The significance of differences between variables was compared using Fisher's exact test and two-sample *t* test set at a 95% confidence interval (two-tailed) with the aid of GraphPad Prism (version 5.01 for Windows, GraphPad Software, San Diego, CA).

## RESULTS

Of the 583 patients treated, 244 were excluded from the study owing to incomplete follow-up ( $n = 130$ ) or other exclusion criteria ( $n = 114$ ). Of the remaining 339 patients who formed the study population, there were 253 males and 86 females, with an average age of 42.8 years (range, 16–90 years) at the time of trauma and a combined total of 498 fractures between them. Zygomatic fractures accounted for the largest percentage (42.37%), followed by orbital floor (33.53%) and mandibular fractures (23.09%). In comparison, there were only few Le Fort-type fractures (1.0%). The distribution of fractures and infections in these patients is summarized in Table 1.

One hundred twenty-five patients received only 1 day of postoperative antibiotics, while the other 214 patients received antibiotics for 5 days or longer (mean [SD], 6.9 [1.9] days). Overall, 12 patients (3.54%) experienced postoperative infections—five patients from Group A (4%) and seven patients from Group B (3.27%). Only 1 infection occurred in a patient with an isolated zygomatic complex fracture, while the other 11 infections occurred in mandibular fractures, which involved either the angle ( $n = 8$ ) or parasymphysis ( $n = 3$ ). Of these 11 patients, 7 had multiple fractures, all of which were within the mandible except for one, which had an additional zygoma fracture.

The infections manifested as a purulent discharge or abscess in three patients of each group. The remaining two

**TABLE 1.** Distribution of Fractures and Infections in the Study Population

Fracture Site	No. Fractures (Percentage of Total)			No. Fractures Subdivided by Treatment/Approach/Region		
	Overall	Group A	Group B		Group A	Group B
Orbital floor fractures	167 (33.53)	65 (13.05)	102 (20.48)	Ethisorb patch	51	74
				Polymax membrane	14	12
				Titanium mesh	0	16
Zygomatic bone fractures	211 (42.37)	72 (14.46)	139 (27.91)	Transconjunctival approach	15	36*
				Lateral orbital approach	30	72
				Intraoral approach	17	12
Mandibular fractures	115 (23.09)	42 (8.43)	73 (14.66)	Percutaneous malar hook	10	19
				Symphysis	2	5
				Parasymphysis	17*	31**
				Angle	11****	17*****
				Condyle with plate fixation	2	7
				Condyle without plate fixation	10	13
Le Fort I	3 (0.60)	1 (0.20)	2 (0.40)			
Le Fort II	2 (0.40)	1 (0.20)	1 (0.20)			

Each asterisk indicates a case that developed a surgical site infection.

patients in Group A and four patients in Group B experienced wound dehiscences (Table 2). All patients with infections were successfully treated with local measures and antibiotics when necessary as described earlier. No plate removal was necessary.

Statistical analysis showed that Groups A and B were comparable and that there was no significant difference in the incidence of infection between the groups receiving postoperative antibiotics for 1 day versus 5 days or more ( $p = 0.77$ ).

## DISCUSSION

In 1987, Chole and Yee<sup>4</sup> showed that the administration of antibiotics in facial fractures reduced the incidence of infective complications from 42.2% to 8.9%. Since then, the use of prophylactic antibiotics has become standard practice.

Together with the use of aseptic technique, infection rates after repair of mandibular fractures have been reduced to 7.3% to 15.2%.<sup>3,15–17</sup> However, the duration of postoperative antibiotic regimens remains controversial, varying from a single dose<sup>5,6</sup> up to even 10 days.<sup>18,19</sup> Unfortunately, there are scant data in the literature comparing infection rates of these various postoperative antibiotic regimens in facial fractures, but in orthognathic surgery, which is also considered “clean-contaminated” surgery, Bentley et al.<sup>20</sup> found a statistically significant difference in the rate of infection between patients who received only 1 day of postoperative antibiotics (60%) compared with those receiving 5 days of antibiotics (6.7%), which contrasts with the findings of others who found no difference.<sup>21,22</sup>

In our study, prophylactic antibiotics were started on admission and continued perioperatively, in line with the

**TABLE 2.** Demographic and Clinical Statistics of the Study Population

	Group A	Group A Infections	Group B	Group B Infections	Total	Total Infections
No. patients	125	5	214	7	339	12
Sex						
Male	94	5	159	7	253	12
Female	31	0	55	0	86	0
Age at time of trauma, mean (SD), y	43.3 (19.5)	26.6 (9.6)	42.5 (19.4)	31.1 (19.0)	42.8 (19.4)	29.3 (15.3)
Elapsed time between trauma and first administration of antibiotics, mean (SD), d	1.9 (4.0)	2.3 (2.5)	1.6 (4.0)	3.5 (3.9)	1.7 (4.0)	3.0 (3.3)
Duration of preoperative antibiotics, mean (SD), d	1.1 (1.1)	1.6 (1.5)	1.1 (1.4)	0.6 (0.5)	1.1 (1.3)	1.0 (1.1)
Time between trauma and operation, mean (SD), d	2.9 (3.8)	3.8 (2.4)	2.7 (4.0)	4.0 (3.7)	2.8 (3.9)	3.9 (3.1)
Operation duration, mean (SD), min	67.6 (54.4)	160 (55.6)	78.4 (55.4)	128.4 (56.0)	74.4 (55.2)	141.6 (55.7)
Median operation duration, min	45.0	135.0	60.0	134.0	60.0	134.5
Duration of postoperative antibiotics, mean (SD), d	1.0 (0.0)	1.0 (0.0)	6.9 (1.9)	6.7 (1.0)	4.7 (3.2)	4.3 (3.0)
Duration of postoperative stay, mean (SD), d	2.4 (1.4)	2.4 (1.1)	2.4 (1.3)	2.4 (1.0)	2.4 (1.3)	2.4 (1.0)
Duration of entire hospitalization, mean (SD), d	3.5 (2.0)	4.0 (1.6)	3.5 (1.9)	3.0 (1.4)	3.5 (2.0)	3.4 (1.5)
Infections						
Abscess/purulent discharge		3		3		6
Wound dehiscence		2		4		6

experiments performed by Burke,<sup>23</sup> who had found that antibiotics given four or more hours after injection of bacteria into a surgical site showed the same degree of cellulitis and inflammation as if no antibiotics had been administered. The duration of postoperative antibiotics depended on whether the study patient was treated before or after April 2011, when there was a shift in department protocol toward a shortened postoperative antibiotic regimen in response to emerging evidence from clinical trials at our department.<sup>11,12</sup>

The fracture distribution in our study was similar to a large-scale craniomaxillofacial trauma review performed by Gassner et al.,<sup>24</sup> with midface fractures making up more than 70% of all fractures, mandible fractures approximately 25%, and a much smaller percentage of Le Fort-type fractures. The overall rate of infection in our study was 3.54% (of patients) or 2.41% (of fracture sites), which is much lower than that reported by Chole and Yee but closer to the study by Zachariades et al.<sup>25</sup> (4.54% of patients, 4.15% of sites). Both studies however corroborated our finding of a much higher incidence of infection after mandibular fractures especially in the tooth-bearing region, as opposed to a very low rate in midface fractures. This could then explain our lower overall infection rate because of the greater proportion of midface fractures in our study population compared with the majority mandibular fractures in these two other studies. The number of patients in our study seemed sufficient for comparison based on power analysis using the prevalence of infections in facial fractures of previous studies. However, because of the very small number of infections in our study, statistical comparison was limited to the overall numbers and the incidence of infection between Groups A and B, but not between the subset of patients who experienced infections. We found that there was no significant difference between the groups in the incidence of infection, which indicated that antibiotic prophylaxis beyond 24 hours postoperatively did not contribute to the prevention of postoperative infections. When analyzing potential confounding factors that could have influenced the rate of infection between the two groups, we found no statistically significant difference with respect to age, interval between trauma and starting antibiotics or between trauma and operation, duration of preoperative antibiotics or operation time, and duration of postoperative stay or entire hospital stay.

In our study population, there was a much higher representation of male patients, with a male-to-female ratio of 3:1. This is consistent with the literature and can be attributed to more males participating in hazardous activities such as extreme sports or getting involved in altercations and road traffic accidents especially under the influence of alcohol. Interestingly, all of the patients who experienced postoperative infections were men. This could be partially caused by the high proportion of males in the overall study population but could also be related to poor compliance with postoperative instructions and hygiene. This became more apparent when the etiology of trauma was examined. In the original study population, altercations were the cause for just more than a quarter of the fractures but accounted for 42% in the infected subgroup. All of these men were in the younger age group and likely to be noncompliant, and this could also explain why our data showed a tendency for younger patients to have a higher

incidence of infection. It is also readily apparent from our results that increased duration of operation led to a higher incidence of infections, which is well recognized and reported in the literature.<sup>14,26,27</sup>

There seemed to be longer mean intervals between trauma and starting antibiotics or trauma and operation for the subgroup of patients who experienced infections. This could be attributed to a couple of outliers who had sought treatment only after a delay of several days for initially missed fractures, when symptoms failed to resolve. The outliers however had a disproportionate influence on the mean values of these variables owing to the small number of infections, and hence, these figures may not be entirely representative. The timing of the appearance of postoperative wound infections in our study was also noteworthy. Wound dehiscence tended to appear much earlier than abscesses or purulent discharges. Wound dehiscence usually became apparent around postoperative Day 10 (mean [SD], 10.7 [5] days), while abscess or purulent discharge were often detected closer to 4 weeks postoperatively (mean [SD], 28.5 [19.3] days). This matches our experience in other clinical situations such as after surgical excision of teeth, where wound dehiscence would appear earlier while abscesses take much more time to develop.

There are limitations inherent in all retrospective studies, and ours is no exception. For example, the inability to standardize treatment approaches (which varied based on clinical presentation, intraoperative findings, and surgeon decision) and the exact duration of postoperative antibiotics in Group B have to be highlighted. The duration of preoperative antibiotics was also variable, since these operations were considered “emergencies” and hence could not be scheduled like elective cases.

Nonetheless, based on the findings of this retrospective study, considered in conjunction with the outcome of previously conducted prospective randomized, double-blind, placebo-controlled trials in our center,<sup>11,12</sup> it can be concluded that prolonged postoperative prophylactic antibiotic use in facial fractures does not have a significant benefit in reducing the incidence of infections.

#### AUTHORSHIP

M.M., O.L., and B.S. contributed in the conception and design of the study. M.M., R.W., and S.P.L. performed the acquisition of data and clinical/literature search. M.M., R.W., S.P.L., and B.S. performed the analysis and interpretation of data collected. M.M., S.P.L., O.L., and B.S., drafted the article and/or provided critical revisions. M.M., S.P.L., K.N., O.L., and B.S. provided final approval and were guarantors of the manuscript.

#### DISCLOSURE

The authors declare no conflicts of interest.

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